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Abstract

EXPERIMENTAL AND THEORETICAL STUDIES OF URANIUM OXIDE LATTICES MODERATED BY MIXTURES OF LIGHT AND HEAVY WATER

by

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Reactor physics measurements on UO_2 lattices moderated by mixtures of light and heavy water have been performed in the NORA zero power reactor at the Kjeller Research Establishment in Norway. The research programme is carried out as a joint project between the International Atomic Energy Agency and Institutt for Atomenergi, Norway.

The fuel used for these experiments has been UO_2 enriched to 3% U^{235} clad in stainless steel. The fuel was made available to the NORA Project by the United States Atomic Energy Commission.

A series of measurements on different H_2O/D_2O ratios and different moderator-to-fuel volume ratios has been completed. Macroscopic and microscopic neutron flux distributions have been measured using different types of foil materials resulting in sets of B_m^2 values and cell parameters for thermal and resonance neutrons.

The ratio of epi-cadmium to sub-cadmium capture in U^{238} (ρ^{28}), the ratio of epi-cadmium to sub-cadmium fission in U^{235} (δ^{25}), and initial conversion ratios have been measured using chemical separation techniques developed at Institutt for Atomenergi.

The ratio of Lu-foil activity to Cu-foil activity has been measured in different positions inside the fuel and in the moderator. The experimental results have been compared to calculated values of the same activation ratio and used as a spectral index for the lattices studied.

Supplementary to experiments on clean critical cores some measurements on two-region cores have been performed. Using the progressive substitution technique these experiments have, at the sacrifice of some accuracy, made it possible to extend the range of measured buckling values considerably.

Analysis of the experimental results using multigroup methods both for the fast and thermal neutron region will be presented.

The neutron energy spectrum in the fast region is calculated by a code BIGG which solves the Fourier transformed one-dimensional transport equation in the B-1 approximation using an extended Greuling-Goertzel treatment of the slowing down process, in 40 energy groups. Resonance absorption and fission are given a correct distribution in energy and are governed by input resonance integrals. BIGG is well adapted to handle slowing down in mixtures of light and heavy water.

The thermal part of the neutron spectrum is calculated by the K-7 THERMOS code which is a multigroup multiregion code solving the space and energy dependent integral transport equation in a heterogeneous reactor cell with cylindrical symmetry and with either reflective or white boundary conditions.